Interview with Xinghua Xia

Q: Could you please introduce to us the methods used in your lab about hydrogen production research?

A: Our lab mainly focused on mimicking active center of hydrogenase with chemical materials to catalyze the production of hydrogen. The main idea lies in mimicking of biomolecules, understanding the mechanics, modulating the function and understanding more mechanics. There are two main issues in bio-mimicking: matching potential energy and coordination of space. For potential energy matching, we need to find metal atoms which have similar potential energy as Ni or Fe in the active center of hydrogenase. The d orbit of this kind of atom must be available for electrons so that it can react with S/N/O to fine-tune its energy level, eventually reaching a similar energy state in the active center of hydrogenase to catalyze hydrogen production. In proteins, the function of metal atoms is to adsorb one H atom, another H atom is adsorbed by side chains of amino acids in the active center. When the two H atoms get close enough, hydrogen can be produced. Thus if we can find the donor of the second H atom, it will be much easier for hydrogen production!

Q: Will the existence of PbrR affect the speed of CdS formation?

A: The formation of CdS precipitation is determined by the radius of atoms. It is a good idea to utilize PbrR to adsorb cadmium and form CdS precipitations *in situ*. The only requirement is that the interaction force between S^{2-} and Cd^{2+} must be bigger than that between PbrR and Cd^{2+}.

Q: What is the basic principle of electron transmembrane transduction?

A: In your experiment, due to silicon encapsulation, it is likely that the reductants can't get inside to fill the hole in semiconducters. Besides, the holes accumulated around the cells have high oxidability and can lead to cell death easily. Therefore, we can choose MV^{2+} to infiltrate the silicon shell because it has a small radius. There are two ways for electron transmembrane transduction. First, if hydrogenase and CdS are close enough, according to the formula below:

$$v = ke^{-\frac{d}{c}}$$

Electrons can get inside the cells due to tunnel effect. Second, the electron transportation process might resemble that in the respiratory chain. From my perspective, I think the first way is possible because the CdS is adsorbed on the outer membrane of the bacteria, indicating that the distance between CdS and the membrane is quite small.

Q: Could you please tell us some ways to detect hydrogen?

A: The electronic method can detect hydrogen in situ. You can also use gas chromatography to detect hydrogen after collecting them.

Q: What is your opinion about our silicon encapsulation?

A: Firstly, the silicon shell must be transparent. Second, the silicon shell can't be too tight. At least it should allow space for reductants to pass through it.

Q: What do you think is the advantage of bio-catalysts over chemical catalysts?

A: Biocatalysts can produce hydrogen under normal temperature and normal atmospheric pressure while chemical ones always require harsh conditions. Thus biocatalysts are more environmentally-friendly. For example, we can artificially mutate the active site of enzymes to increase its efficiency. We can also combine bio-systems and chemical methods together.

Q: What is the current bottleneck for worldwide application of hydrogen energy?
A: The ridiculously high cost and difficulty in store and transportation.